

*Measures of Double and Proper-Motion Stars.* By Dr. J. E. de Vos van Steenwijk, F.R.A.S.

The following measures have been executed with the  $10\frac{1}{2}$ -inch refractor at the Leyden Observatory, from May 1918–June 1919.

The telescope and micrometer have been described at length by J. Voûte, who used them for the same purpose, in part x. of the *Annalen der Sternwarte zu Leiden*. The revolution value of the micrometer-screw I have determined anew on several nights, by measurements of the AZ arc in Perseus and by chronographic transits. The value adopted was  $30''\cdot86$ , whereas Voûte used  $30''\cdot88$ .

The methods of observation did not differ in any respect from the usual ones, except that throughout the work wire-illumination was used; this was found very satisfactory for the faint and wide pairs, which formed the greater part of the programme, and did not lead to inconvenience, as the illumination is strictly symmetrical. The power used varied, according to the condition of the air and the required field of view, between 238 and 600.

The observing list was constructed with regard to the fact that the bad seeing prevailing at Leyden prevents the measuring of close pairs on many nights. Therefore a selection was made from Burnham's "Measures of proper-motion stars," and the list completed with pairs of the 61 Cygni type and others where relative motion was only surmised.

New relative proper motions have been derived for many Burnham pairs, especially when more than one set of older measures was at hand. For the comparison with meridian proper motions the reader is referred in most cases to the work cited above.

About those proper motions I want to say a few words. Though at present nobody can agree with the verdict of Burnham that a star below, say, the ninth magnitude, having a sensible proper motion is so improbable a thing that the relative motions found in such cases may be always accepted as wholly belonging to the brighter star, still I believe that the results deduced in this way retain their value. They may serve a double purpose. Firstly, as a good approximation in the case of those rapidly moving stars of which older meridian observations are wanting. *Individual* proper motions of rapidly moving stars (especially of the fainter ones) are of interest because they form the exceptions to the statistical rules of velocity distribution and belong probably to our nearer neighbours.

On the other hand, if a good meridian proper motion of the principal star is to be obtained, we can deduce the absolute proper motion of the companion. These form a valuable check on our rapidly accumulating stock of photographic proper motions. Also they might be directly used as Comstock did in his determination of the solar apex from very faint stars, which determination could now be repeated from much better data.

*Explanation of the Table.*

Most of the columns are self-explanatory. The nomenclature of Burnham is always followed even in the case of stars not given in the General Catalogue and in the lettering of multiple pairs. The magnitudes are also borrowed from Burnham in nearly all cases. If in the column giving the number of nights ( $n$ ) a figure between brackets is added, this means that only on those nights complete measures have been taken; on the remaining nights only a position-angle has been measured. Under the heading remarks, (P.M.) means that the pair is to be found in Burnham's Measures of proper-motion stars and (De) in the Dearborn Catalogue by Fox. An asterisk refers to the more explicit notes at the end of the table. For rapidly moving pairs the yearly results are printed separately.

Name.	Epoch. 1900+	Mag.	P.A.	D.	$n$ .	Remarks.
$\beta$ 12740 AD	18'86	8'6, 11'0	179°57	84''71	1	(P.M.)
„ AE	18'86	8'6, 11'0	58'37	80'56	1	(P.M.)
Groomb. 34	18'76	8'3, 9'5	56'44	38'56	1	(P.M.)
$\beta$ 190	18'69	8'8, 8'8	335'2	...	2	Twilight; no distance. (De.)
$\beta$ 246	18'76	8'5, 9'0	113'2	5'55	3	Change in distance.
$\beta$ 319	18'76	8'2, 9'5	11'46	62'37	1	(P.M.)
B.D. $\left\{ \begin{smallmatrix} 32^{\circ} 120 \\ 33^{\circ} 99 \end{smallmatrix} \right.$	18'86	8'5, 9'5	180'34	283'5	1	(P.M.)
$\beta$ 391	18'88	5'7, 9'7	160'17	35'84	2	*
$\beta$ 426	18'94	4'0, 7'6	255'9	7'08	3	$\eta$ Cassiop. (De.)
Lal. 1532	18'96	7'5, 9'8	215'24	60'16	1	(P.M.)
$\beta$ 609	19'15	7'5, 8'0	191'15	14'62	3 (2)	One distance measure rejected.
$\beta$ 697	18'96	6'6, 8'5	346'85	53'85	4 (3)	(P.M.) Change in angle no certain.
Lal. 2682 AB	18'85	8'2, 9'1	74'60	82'69	2	(P.M.) *
„ AD	18'85	8'2, 10'3	188'78	80'39	2 (1)	(P.M.) Epoch D=18'94. *
Lal. 2701	18'71	8'5, 9'0	347'68	184'97	1	(P.M.)
B.D. $30^{\circ} \left\{ \begin{smallmatrix} 229 \\ 230 \end{smallmatrix} \right.$	18'71	8'7, 9'2	251'70	89'77	1	(P.M.)
$\beta$ 860	18'90	8'2, 8'4	359'42	13'20	1	(P.M.)
$\beta$ 878	18'81	9'2, 9'3	241'88	18'29	2	Relative proper motion but measures discordant. *
$\beta$ 900	18'87	8'4, 8'7	234'8	...	1	
$\beta$ 1008 Bb	18'91	6'0, 9'2	257'65	203'85	2	(P.M.)
$\beta$ 1027	18'88	7'0, 8'5	24'5	...	1	Angle unchanged since 1900.
$\beta$ 1131	18'77	7'0, 8'0	331'73	66'86	2	(P.M.)
B.D. $67^{\circ} 191$	18'72	7'8, 9'3	101'49	36'18	2	(P.M.)

Dec. 1919. *Measures of Double and Proper-Motion Stars.* 225

Name.	Epoch. 1900+	Mag.	P.A.	D.	n.	Remarks.
1350	18'95	9'4, 9'4	62°0	3'83	2 (1)	Change in angle probable; distance measure unreliable.
1386	18'86	6'0, 9'2	313'4	...	1	
1393	18'82	4'0, 10'0	301'00	17'58	2	9 Persei.
1427	18'88	7'3, 8'2	315'0	3'56	2	
1520	18'94	9'4, 10'0	59'2	3'78	2	(De.) *
al. 5586	18'81	7'1, 9'2	265'92	85'90	2	(P.M.) DM. 35° $\begin{cases} 615 \\ 616 \end{cases}$ *
al. 5712	18'81	7'0, 8'4	246'62	119'34	2	(P.M.) Distance measures discordant.
1787	18'98	6'0, 8'2	253'0	6'50	2	
r. 536	19'02	7'0, 9'5	153'80	95'82	3	(P.M.) *
9 Tauri	18'91	6'5, 8'2	1'98	170'09	2	(P.M.) *
2115	18'99	8'0, 8'0	118'6	...	1	(De.)
1 Tauri	18'85	5'9, 9'5	62'25	166'21	2 (1)	(P.M.)
2143	19'06	9'6, 9'6	203'4	3'70	1	(P.M.) Perhaps increase in distance.
2163	19'00	6'0, 8'8	35'0	4'72	3 (2)	(P.M.)
1 Tauri	19'05	5'9, 9'0	338'68	161'95	1	(P.M.) No change.
2232	19'04	9'5, 9'5	286'0	4'83	2	
2272	18'87	8'5, 9'0	325'2	2'10	1	(De.)
2284	18'88	6'5, 6'5	197'6	3'68	2	(De.)
2336	18'97	8'0, 8'0	294'4	4'34	2	
Orionis	19'08	5'0, 8'7	249'18	171'36	2	Distance measures discordant. (P.M.)
2435	18'88	4'0, 7'9	356'4	5'30	2	Change in angle and distance now certain. (P.M.)
2445	18'86	6'0, 9'7	259'9	3'18	1	
2525	19'05	9'5, 10'2	210'9	...	1	(De.)
3004	19'12	7'0, 9'0	111'3	...	1	(De.)
3074	AB 18'97	3'0, 7'5	339'6	2'64	2	(9 Aurigæ.)
„	AD 19'06	3'0, 9'5	349'60	130'29	2	(P.M.)
3423	AB 19'04	6'7, 7'7	330'0	4'76	2	Groomb. 1173; perhaps increase in angle, no change in distance.
„	BC 19'04	7'7, 10'0	27'02	136'60	2	*
3692	19'00	5'4, 7'7	157'8	6'58	2	
.D. 22°1620	19'15	7'2, 10'0	264'11	95'11	2	No change.
3949	19'18	7'5, 7'5	105'8	1'86	2	(De.)
4159	19'00	7'0, 7'0	178'01	64'27	2	*

Name.	Epoch. 1900+	Mag.	P.A.	D.	n.	Remarks.
$\beta$ 4122	AB 19'00	2'0, 2'8	215'7	4'99	2	Castor.
„	AC 19'18	2'0, 10'0	164'17	73'17	2	Comes estimated much brighter.
Lal. 15394	AB 19'11	7'9, 10'1	258'49	87'01	2	(P.M.)
„	AC 19'11	7'9, 10'4	83'11	122'12	2	(P.M.)
$\beta$ 4361	AB 19'19	5'5, 9'0	76'46	88'02	3 (2)	One distance measure (88''79) rejected.
„	AC 19'15	5'5, 9'1	150'60	119'95	2	
$\beta$ 4402	19'24	7'8, 9'7	231'3	1'73	2	
$\beta$ 4477	AC 19'09	5'0, 5'5	110'6	6'21	3 (2)	$\zeta$ Cancri.
Lal. 15976	AB 19'14	7'5, 9'0	159'82	131'36	3 (2)	Epoch dist. meas. 19'21. (P.M.)
„	BC 19'24	9'0, 11'0	153'07	101'32	2	(P.M.) Distance measures discordant. *
Lal. 16494	19'16	7'5, 9'5	43'79	155'51	1	(P.M.)
$\beta$ 4609	AC 19'21	3'4, 10'0	150'46	142'92	2	(P.M.) *
$\beta$ 4710	AC 19'26	6'5, 9'0	342'23	63'10	2	(P.M.)
„	AD 19'26	6'5, 9'0	43'32	82'64	2	(P.M.)
39 & 40 Cancri	AB 19'09	6'7, 6'9	151'01	150'14	2	(P.M.)
„	Aa 19'15	6'7, 9'0	309'10	134'42	2	(P.M.) Distance measures discordant.
„	Ab 19'15	6'7, 9'0	110'68	135'43	2	(P.M.)
„	BC 19'25	6'9, 10'8	147'03	140'03	1	(P.M.)
$\gamma$ Cancri	19'21	5'0, 9'2	66'09	106'28	2	(P.M.) *
$\beta$ 4771	19'29	3'8, 7'8	245'6	3'46	2	$\epsilon$ Hydræ.
Pi. VIII. 174	AB 19'15	8'0, 9'3	322'22	166'82	2	(P.M.) *
„	AC 19'15	8'0, 9'4	281'06	222'88	2 (1)	One distance measure rejected.
$\beta$ 4815	AB 19'21	7'5, 7'6	48'8	4'38	2	(P.M.)
$\beta$ 4819	19'18	7'0, 8'0	313'31	44'28	2	B=B.D. 26°1854. *
$\beta$ 4923	AC 19'21	5'0, 9'4	147'85	204'57	2 (1)	$\sigma^2$ Ursæ Maj. One dist. meas. rejected
80 Cancri	AB 19'19	6'5, 9'1	252'01	133'36	2	(P.M.)
„	BC 19'27	9'1, 9'6	317'30	148'32	1	(P.M.) No relative change since 1909.
$\beta$ 4972	AB 19'18	7'4, 7'4	69'25	18'88	2	
„	AC 19'27	7'4, 10'0	196'70	144'75	1	
$\beta$ 4999	19'19	8'3, 8'5	249'90	18'08	2	
$\beta$ 5023	AB 19'22	6'1, 10'2	126'3	5'56	1	Angle increasing, no change in distance.
„	AC 19'16	6'1, 10'0	4'99	142'89	1	(P.M.)

Dec. 1919. *Measures of Double and Proper-Motion Stars.* 227

Name.	Epoch. 1900+	Mag.	P.A.	D.	n.	Remarks.
5131	19'24	5'0, 9'5	74°72	37'23	2	(P.M.)
5171	19'21	7'0, 8'3	290°2	3'14	3 (2)	Groomb. 1569.
5175	19'26	4'0, 9'3	43°00	85'34	2	(P.M.).
Gal. 19627	19'21	8'8, 9'4	255°63	180'24	2	(P.M.) *
Groomb. 1618	AB 18'34	6'7, 8'8	187°12	165'44	2	(P.M.) *
5356	AB 18'76	6'1, 7'0	167°42	16'64	2	Fixed.
„	AC 19'19	6'1, 10'0	11°50	150'06	1	(P.M.)
Groomb. 1636	18'76	6'5, 8'8	102°60	150'58	2	(P.M.) *
5385	19'25	8'6, 9'3	50°9	...	2	
5695	AB 18'36	7'7, 8'7	265°60	35'15	2	*
„	AC 18'70	7'7, 8'0	334°84	167'56	3	(P.M.)
5721	19'00	7'4, 8'0	257°29	80'35	4	(P.M.)
5734	{ 18'37 19'22	{ 4'4, 4'9 4'4, 4'9	{ 110°8 105°9	{ 3'20 3'09	{ 4 1	{ ξ Ursæ Majoris.
5739	19'29	6'9, 8'1	17°8	3'17	4	Distance decreasing.
5850	19'32	9'5, 9'8	29°2	2°82	3 (2)	Change in angle confirmed, cf. De.
5858	AB 19'16	6'0, 8'0	258°36	9'99	3	
„	AC 19'25	6'0, 10'0	88°81	114°41	3	(P.M.) Comes estimated much brighter.
5887	AC 18'34	9'3, 9'2	275°83	45°06	2	Measures uncertain.
6043	19'24	9'7, 9'9	258°07	9°40	3 (2)	De. *
Gal. { 22662 22667 }	18'68	8'8, 9'0	97°59	113°71	3	(P.M.) *
6064	18'61	7'5, 7'7	221°85	12°27	4	(P.M.) Increase of distance confirmed; angle perhaps decreasing.
6084	AC 19'31	7'5, 9'7	293°18	156°84	3	(P.M.) *
„	AD 19'38	7'5, 9'0	Δδ=136''19	...	3	(P.M.) *
6090	AB 18'90	7'5, 7'8	279°2	7°24	3	(P.M.)
„	AC 18'90	...	176°34	98°72	3	(P.M.)
6154	19'32	9'3, 9'6	148°00	23°86	3 (2)	(P.M.) Change in distance not confirmed.
Can. Ven.	AC 19'00	6'5, 8'7	327°24	229°01	5 (3)	(P.M.)
Virginis	AB 19'04	5'0, 9'0	137°22	173°44	3	(P.M.) *
„	AC 19'38	5'0, 10'3	110°25	...	2	(P.M.) Through clouds.
6230	19'01	8'0, 9'3	107°71	53°47	3	Distance measures erratic. (P.M.)
6242	18'85	6'5, 9'2	281°45	84°71	4 (3)	Epoch D=19'01; no relative change.

Name.	Epoch. 1900+	Mag.	P.A.	D.	n.	Remarks.
34 Virginis	18'99	6.2, 9.4	3°82	139°27	3	(P.M.) *
Pi. XII. 188	AB 19'20	7.0, 10.0	355.63	158.73	3 (2)	(P.M.) *
"	BC 18'95	10.0, 9.4	328.10	135.58	3 (2)	(P.M.) *
$\beta$ 6289	AB 18'35	6.8, 7.3	202.07	16.30	4	
"	AC 18'68	6.8, 8.0	325.62	246.04	3	(P.M.)
"	BC 18'37	...	328.7	255.94	1	(P.M.)
$\beta$ 6318	AB 18'70	6.3, 8.2	284.0	3.91	4	(De.) Common prop. motion, an perhaps increase in distance.
$\beta$ 6389	19'14	6.5, 8.5	254.0	...	3	Change in angle confirmed, cf. Ger Cat.
$\beta$ 6405	AB 18'86	4.0, 9.0	343.1	7.02	2	Fixed.
"	AC 19'09	4.0, 9.0	299.22	71.61	4	(P.M.)
$\beta$ 6476	18'91	8.3, 8.5	345.5	...	4	Angle still increasing. Difficu object.
$\beta$ 6566	AC 18'36	5.0, 10.5	123.0	1.42	2	
"	AD 18'40	5.0, 9.5	140.40	220.25	2	
$\beta$ 6586	18'86	6.2, 9.1	141.1	4.66	4 (1)	Epoch D = 19'35.
$\beta$ 6776	{ 18'40	8.2, 8.5	80.1	...	2	}
	{ 19'35	8.2, 8.5	84.6	2.25	2	
$\beta$ 6778	18'87	5.1, 7.2	236.76	13.10	4	*
$\beta$ 6837	18'88	7.0, 7.0	171.8	5.73	4	Change in distance confirmed. *
$\beta$ 6869	AB 18'36	9.0, 9.0	74.90	45.60	2	(P.M.)
"	AC { 18'36	9.0, 8.9	117.40	163.61	2	} (P.M.)
	{ 19'37	9.0, 8.9	117.27	162.48	2	
$\beta$ Boötis	18'36	4.4, 11.0	181.49	69.11	1	(P.M.) No change.
$\beta$ 7040	19'07	8.5, 10.2	201.8	...	3	
{ 45 Boötis	AC 18'34	5.2, 9.5	41.10	244.14	2	} (P.M.)
"	" 19'39	5.2, 9.5	40.74	243.97	2	
$\alpha$ Coronæ	18'89	5.7, 9.6	337.98	146.96	4	(P.M.) Older measures discordan
$\beta$ 7222	18'91	4.7, 9.3	16.6	2.93	4	
$\beta$ 7259	18'36	7.3, 7.9	50.5	1.79	2	$\mu_2$ Boötis. *
"	AC 18'36	7.3, 4.9	171.25	108.55	2	$\mu_1 - \mu_2$ Boötis.
$\beta$ 7277	BC 19'14	9.5, 9.5	282.1	8.81	4	
"	AE 19'36	8.8, 10.7	53.27	146.48	2	
$\beta$ 7327	18'89	8.5, 8.5	304.73	56.09	4	(P.M.)

Dec. 1919. *Measures of Double and Proper-Motion Stars.* 229

Name.	Epoch. 1900+	Mag.	P.A.	D.	n.	Remarks.	
7332	AB 18.36	6.8, 7.9	199.4	1.08	2		
„	AC 18.63	6.8, 7.0	327.91	122.22	4		
Serpentis	AB 18.90	6.2, 9.1	207.65	207.26	4	(P.M.)	
„	BC 18.90	9.1, 7.4	235.56	172.08	4	(P.M.)	
„	Aa 18.73	6.2, 10.8	281.20	171.54	3 (2)	(P.M.) Epoch D = 18.42. *	
7442	18.92	5.7, 9.5	64.71	96.30	4	*	
„ Herculis	AB 19.15	7.5, 9.8	257.40	65.07	4	(P.M.) *	
„	BC 18.43	9.8, 11.0	17.72	108.37	1	(P.M.)	
„	AC 19.36	...	341.06	109.49	2 (1)		
7466	AB 18.38	8.2, 8.2	39.68	27.72	2		
„	AC 18.75	8.2, 9.5	178.60	242.15	3 (2)	Epoch D = 18.93.	
7500	AB 18.90	6.5, 8.0	325.32	35.27	4		
„	AC 18.90	6.5, 9.8	137.57	167.34	4		
7563	AB 18.94	4.9, 5.2	218.1	5.18	2		
„	AD 18.97	4.9, 10.3	85.46	66.52	2	Distance measures discordant.	
7649	AB 18.38	4.0, 6.1	84.6	1.05	1	$\lambda$ Ophiuchi.	
7649	Aa 18.41	4.0, 10.0	246.63	313.60	1	No older measures.	
„	AC 18.92	4.0, 8.8	169.65	119.14	2 (1)	(P.M.) Epoch D = 18.44.	
7699	19.12	8.0, 9.5	237.80	4.68	4 (3)	Epoch D = 19.03. *	
Ophiuchi	19.08	5.0, 9.8	69.33	94.12	3	(P.M.) *	
7792	19.24	7.0, 10.3	185.2	...	4	Kü. I. (De.) decrease in angle.	
7845	AB 18.97	5.8, 6.3	116.00	298.90	4		
„	Ba 18.97	6.3, 9.0	267.98	152.35	4	Distance measures very discordant.	
„	ab 19.04	9.0, 9.5	209.58	98.71	4	Some relative motion.	
7858	AC 18.85	6.4, 9.6	174.20	146.04	3	(P.M.) *	
7863	AB-C 19.06	8.2, 9.2	85.22	172.33	3	(P.M.) C = B.D. 0°3634.	
D. 42°	$\left\{ \begin{smallmatrix} 2810 \\ 2808 \end{smallmatrix} \right\}$	$\left\{ \begin{smallmatrix} 18.43 \\ 19.41 \end{smallmatrix} \right\}$	$\left\{ \begin{smallmatrix} 9.4, 9.2 \\ 9.4, 9.2 \end{smallmatrix} \right\}$	$\left\{ \begin{smallmatrix} 280.44 \\ 280.57 \end{smallmatrix} \right\}$	$\left\{ \begin{smallmatrix} 204.42 \\ 202.90 \end{smallmatrix} \right\}$	$\left\{ \begin{smallmatrix} 2 (1) \\ 1 \end{smallmatrix} \right\}$	$\left\{ \begin{smallmatrix} (P.M.) * \\ (P.M.) \end{smallmatrix} \right\}$
7922	18.98	3.0, 8.1	200.54	12.41	4	$\delta$ Herculis.	
3068	AC 19.18	7.0, 7.7	211.70	82.64	4		
„	CD 18.44	7.7, 10.5	180.32	143.75	1	(P.M.)	
D. 18°3424	AB 18.48	9.0, 10.3	265.00	267.86	1	(Through clouds.) $\Delta\delta = 23''36$ .	
„	19.40	9.0, 10.3	only $\Delta\delta$	23.05	2	(P.M.) *	
„	AC 19.38	9.0, 9.0	„ $\Delta\delta$	5.46	3	*	
3162	A-BC 18.55	10.0, 3.4	245.68	32.81	2	$\mu$ Herculis.	

Name.	Epoch. 1900+	Mag.	P.A.	D.	n.	Remarks.
$\beta$ 8211	19'10	7'5, 9'1	124°80	19''01	3	(P.M.) Increase in distance n confirmed.
$\beta$ 8295	AB 19'24	7'0, 7'1	41'61	57'21	4	*
„	BC 19'83	7'1, 9'8	339'27	184'74	3	Epoch D = 19'94. *
$\beta$ 8354	AD 18'98	6'8, 9'3	191'12	200'74	2	
Pi. XVII. 368	18'62	7'7, 10'0	240'92	131'89	1	(P.M.)
$\beta$ 8404	18'77	8'5, 9'0	339'92	27'57	4 (3)	Epoch D = 18'86. *
$\beta$ 8574	AB 19'00	4'7, 7'7	267'4	3'85	4	Increase in distance confirmed.
„	AC 18'82	4'7, 7'1	20'32	89'09	3	
$\beta$ 8894	AC 18'57	7'0, 8'5	5'22	150'70	2	
„	BD 18'57	7'1, 9'0	358'80	149'51	2	
$\beta$ 8986	19'02	7'9, 8'4	118'65	23'92	4	
Lal. 35851	18'95	5'5, 9'5	276'69	122'21	3 (2)	Epoch D = 18'65. Distance u certain.
Oxf. 26°55357	18'87	8'4, 9'5	38'47	80'39	3	B.D. 25° { 3780 3783 } *
$\beta$ 9137	18'80	6'0, 6'5	217'0	8'96	4	
$\beta$ 9150	19'01	8'5, 9'1	271'2	3'29	4	(De.) Holden 34. *
$\beta$ 9308	AC 18'65	5'5, 9'5	322'74	70'72	2	
„	AD 18'64	5'5, 9'5	63'70	149'62	2 (1)	One distance measure rejected.
$\beta$ 9493	18'58	9'2, 9'4	190'0	7'94	2	(P.M.) Decrease in distance n confirmed ; fixed.
$\beta$ 9560	18'79	5'1, 5'3	134'58	38'64	4	
$\beta$ 9607	AD 18'68	6'6, 9'5	250'99	143'52	3 (2)	(P.M.) Change in both co-ordinates confirmed. *
$\beta$ 9617	18'93	5'1, 8'1	70'42	25'75	3	Change still doubtful.
$\beta$ 9652	18'43	9'1, 9'2	274'9	...	1	*
$\beta$ 9713	18'92	4'0, 7'6	8'2	3'24	4 (2)	Epoch D = 19'22. ( $\epsilon$ Draconis.)
Lal. 37626	19'10	7'2, 9'5	119'72	100'77	2 (1)	Epoch D = 18'68. (P.M.)
15 Sagittæ	AB 18'66	6'0, 8'8	275'93	190'73	2	(P.M.) *
„	AC 18'66	6'0, 7'0	319'95	203'70	2	(P.M.) *
„	Bb 18'66	8'8, 9'2	230'92	183'44	2	(P.M.) *
$\beta$ 9949	18'96	8'0, 9'5	13'0	5'28	3	(P.M.)
29 Cygni	AB 18'77	5'0, 7'0	153'37	212'65	2	(P.M.) *
„	AC 18'71	5'0, 10'0	22'89	221'71	2	*
„	BD 18'71	7'0, 10'6	119'99	217'40	2	*



Dec. 1919. *Measures of Double and Proper-Motion Stars.* 231

Name.	Epoch. 1900+	Mag.	P.A.	D.	n.	Remarks.
$\beta$ 10044	18'93	7'0, 9'1	115°6	5'37	3	(P.M.)
Cephei H 6	18'94	4'7, 9'5	161°39	66'42	3	B=B.D. 57°2241. *
Lal. 40604	AC 18'80	7'8, 9'0	23'59	152'92	2	(P.M.) *
„	BC 18'66	10'0, 9'0	69'30	87'60	2	(P.M.) *
„	CD 18'66	9'0, 10'2	356'10	92'84	2	(P.M.)
$\beta$ 10587	18'69	8'7, 10'2	304'6	9'98	2	(P.M.) Relative motion confirmed.
61 Cygni	AB 18'69	5'6, 6'3	131'75	23'95	3	$\beta$ 10732.
„	AC 18'66	5'6, 10'5	31'07	157'13	2 (1)	No older measures.
„	AD 18'82	5'6, 8'5	282'25	304'89	2	„
61 Cygni	AE 18'82	5'6, 8'0	12'28	305'97	2	No older measures.
B.D. 10°4481	18'80	8'6, 9'5	356'87	186'45	3	(P.M.) *
Oxf. 26°74272	18'66	9'4, 10'3	19'70	126'64	2	(P.M.) *
$\beta$ 11214	AD 18'79	4'0, 7'0	52'90	204'61	2	( $\mu$ Cygni.)
$\beta$ 11355	18'67	9'2, 9'3	164'25	2'53	3 (1)	The single distance measure probably erroneous.
$\beta$ 11483	19'14	4'7, 6'5	280'5	7'19	4	( $\xi$ Cephei.)
Br. 2926	18'64	5'4, 10'5	33'57	72'88	2	(P.M.) * Companion estimated much brighter.
$\epsilon$ Cephei	18'64	4'5, 9'6	15'40	127'80	2	(P.M.) *
$\beta$ 11641	AC 18'74	6'0, 9'6	176'73	222'0	2	Position angle erratic. *
„	BC 18'74	8'2, 9'6	174'60	206'90	2	*
$\beta$ 11761	AC 18'64	9'2, 9'0	59'33	52'66	2	(Krüger 60.) (P.M.)
„	AD 18'64	9'2, 8'0	140'27	201'54	2	(P.M.)
$\beta$ 11968	AB 18'79	7'0, 7'5	261'2	3'32	2	
„	AC 18'79	7'0, 8'2	122'48	46'98	2	
$\beta$ 12053	18'80	8'7, 10'5	87'37	...	2	
$\beta$ 12104	18'94	8'4, 8'5	112'3	...	1	
$\beta$ 12179	18'74	5'6, 10'6	348'14	48'28	2 (1)	Slow relative motion.
$\beta$ 12214	AB-C 18'62	8'0, 9'4	327'92	40'99	1	(P.M.)
„	AB-D 18'62	8'0, 10'0	280'10	50'39	1	(P.M.)
$\beta$ 12290	AC 18'83	8'2, 10'8	358'93	104'96	2	(P.M.) Many older measures.
„	AD 18'79	8'2, 9'5	330'15	192'32	2	(P.M.)
„	AE 18'79	8'2, 9'5	294'82	205'67	2	No other measures.
12 Andromed.	18'78	6'0, 8'7	255'93	121'15	2	(P.M.) *
$\beta$ 12381	18'76	8'1, 10'4	278'9	7'84	1	(P.M.)
$\beta$ 12467	18'71	9'5, 9'6	155'0	11'60	1	(P.M.)

Name.	Epoch. 1900+	Mag.	P.A.	D.	n.	Remarks.
$\beta$ 12495	18.76	8.3, 8.5	119°4	5"28	2	Distance decreasing ?
P. XXIII. 164 AB	18.66	7.0, 9.5	213.28	106.26	2	(P.M.) *
„ AC	18.66	7.0, 9.5	141.43	118.91	2	(P.M.)
„ AD	18.66	7.0, 9.2	190.99	171.32	2	(P.M.)
„ AE	18.66	7.0, 9.0	125.80	159.64	2	(P.M.)
„ AF	18.66	7.0, 9.0	191.95	225.28	2	(P.M.)
12538	18.65	8.9, 9.0	82.77	50.50	2 (1)	(P.M.) Large relative motion.
$\beta$ 12608	AC 18.76	6.8, 9.0	132.73	160.93	2	C=B, D. 74° 1049. *
$\beta$ 12656	AC 18.76	7.7, 10.0	245.72	45.46	1	(P.M.) *
$\beta$ 12693	Aa 18.73	6.3, 9.8	324.08	155.49	2	A=U Cassiop. *
„ Bb	18.73	7.7, 9.9	129.63	134.42	2	*
$\beta$ 12701	AC 18.81	5.9, 8.5	333.81	57.09	2	Cf. Gen. Cat., p. 1046.

## Notes.

$\beta$  391. A and B have common p.m. (measures 1903–1919); perhaps also some relative motion in  $\delta$ .

Lal. 2682. From AB and AD exactly same p.m. of A,

$$\mu_{\alpha} = +0''.515, \mu_{\delta} = +0''.213.$$

For meridian values, cf. (P.M.).

$\beta$  878. Measures (1900–1919) too discordant for reliable p.m.

B.D. 67° 191. p.m. from measures 1892–1919,

$$\mu_{\alpha} = +0''.543, \mu_{\delta} = +0''.290.$$

For meridian values, cf. (P.M.).

$\beta$  1520. Older measures:

1901.56	56° 4	3" 20	Kü. 2n.
1909.84	55° 1	3" 44	Doo. 2n.
1912.13	53° 8	2" 94	De 3n.

My measures disagree with those of Dearborn, which are termed erratic there. My separate results are:

$$62^{\circ} 3 \quad 4'' 01 \quad \text{and} \quad 56^{\circ} 1 \quad 3'' 55.$$

Lal. 5586. p.m. deduced from place in A.G. Lund. 1889, and measures of  $\beta$  (1907.8), and my own,

$$\mu_{\alpha} = +0''.161, \mu_{\delta} = +0''.030.$$

Br. 536. p.m. from four sets of measures (1886–1919),

$$\mu_{\alpha} = -0''.015, \mu_{\delta} = -0''.022.$$

Meridian values very discordant:

$$\text{Boss } \mu_{\alpha} = -0''.023, \mu_{\delta} = +0''.013.$$

$$\text{Newcomb } \mu_{\alpha} = -0''.180, \mu_{\delta} = +0''.024.$$

39 Tauri. p.m. from measures 1887-1918,

$$\mu_{\alpha} = +0''.184, \mu_{\delta} = +0''.059.$$

$\beta$  3423. From three sets of measures of B.C. (1880-1919),  
the p.m. of the close pair is found to be,

$$\mu_{\alpha} = -0''.022, \mu_{\delta} = +0''.071.$$

$\beta$  4159. The relative p.m. of this pair of equal magnitude from  
four sets of measures (1875-1919),

$$\mu_{\alpha} = -0''.013, \mu_{\delta} = +0''.029.$$

Lal. 15976. Relative motion of A from measures AB (1893-1919),

$$\mu_{\alpha} = -0''.352, \mu_{\delta} = +0''.234.$$

Relative motions of B from BC (1908-1919),

$$\mu_{\alpha} = -0''.008, \mu_{\delta} = -0''.092,$$

but distance measures discordant.

$\beta$  4609. From four sets (1888-1919),

$$\mu_{\alpha} = -0''.130, \mu_{\delta} = +0''.110,$$

agrees with meridian values, *cf.* (P.M.).

$\gamma$  Cancri. p.m. from four sets (1888-1919),

$$\mu_{\alpha} = -0''.104, \mu_{\delta} = +0''.026,$$

agrees with meridian values, *cf.* (P.M.).

Pi. VIII. 174. p.m. of A is given from three sets of AB and AC  
(1893-1919), in good accordance, showing relative motions  
of BC to be imperceptible.

$$\text{From AB is } \mu_{\alpha} = +0''.049, \text{ and } \mu_{\delta} = +0''.208.$$

$$\text{From AC is } \mu_{\alpha} = +0''.055, \text{ and } \mu_{\delta} = +0''.218.$$

For meridian values, *cf.* (P.M.).

$\beta$  4819. p.m. from four sets (1875-1919),

$$\mu_{\alpha} = +0''.051, \mu_{\delta} = +0''.025.$$

Lal. 19627. p.m. from three sets (1893-1919),

$$\mu_{\alpha} = -0''.234, \mu_{\delta} = +0''.096.$$

Meridian values very discordant *cf.* (P.M.).

Gr. 1618. p.m. from three sets (1894-1919),

$$\mu_{\alpha} = -1''.303, \mu_{\delta} = +0''.483.$$

For meridian values *cf.* (P.M.).

Gr. 1636. p.m. from three sets (1893-1919),

$$\mu_{\alpha} = +0''.010, \mu_{\delta} = +0''.257.$$

All meridian values larger, *cf.* (P.M.).

$\beta$  5695. All the measures of this pair are :

1881.85	264°.3	36".03
1894.37	264°.6	35".59
1918.36	265°.6	35".15

This pair has a common p.m. of  $0''.546$ ;  $\beta$  finds no relative change, but now it is evident, and a pair of the 61 Cygni type.

$\beta$  6043. Kü. No. 2. All the measures are :

1901.32	254°.2	8".84	Kü. (2)	Increase of angle,
1911.62	257°.1	9".85	Doo. (4)	change in distance
1912.07	256°.3	9".16	De (3)	not yet certain.
1919.24	258°.1	9".40	(3)	

Lal. 22662 and 22667. Relative p.m. from three sets (1891-1919),

$$\mu_{\alpha} = -0''.146, \mu_{\delta} = -0''.592.$$

Küstner gives p.m. of A and B; from them the relative motion of A is :

$$\mu_{\alpha} = -0''.176, \mu_{\delta} = -0''.573.$$

$\beta$  6084. From four sets of AC (1864-1919),

$$\mu_{\alpha} = +0''.090, \mu_{\delta} = +0''.130.$$

Meridian p.m. has another direction, *cf.* (P.M.).

$\beta$  6084 AD.  $\beta$  gives  $\Delta\delta = 136''.7$  for 1901.1. These measures do not agree with the value of  $\Delta\delta = 139''.9$  in the A.G. Leipzig for 1884.1.

$\chi$  Virg. p.m. from four sets of AB (1886-1919),

$$\mu_{\alpha} = -0''.050, \mu_{\delta} = +0''.024.$$

Meridian observations give larger values, *cf.* (P.M.).

34 Virg. From two sets (1909-1919),

$$\mu_{\alpha} = +0''.101, \mu_{\delta} = +0''.062.$$

This does not agree with the meridian p.m. of A.

[Auwers  $+0''.038$ ,  $+0''.019$ ; Boss  $+0''.048$ ,  $+0''.026$ ], but the interval is only ten years.

Pi. XII. 188. From three sets of AB (1893-1919),

$$\mu_{\alpha} = +0''.212, \mu_{\delta} = +0''.123.$$

For meridian values, *cf.* (P.M.).

Pi. XII. 188 AC. No change; measures Engelmann must have been erroneous.

$\beta$  6778. Increase in distance as announced in Gen. Cat. not confirmed by my measures and those of Dearborn.

$$1908.43 \quad 236^{\circ}7 \quad 13''.12 \quad (3n) \text{ De.}$$

Dec. 1919. *Measures of Double and Proper-Motion Stars.* 235

$\beta$  6837. Change in distance confirmed. Some of the latest measures are :

1907.31	169°.2	5".59	Lau A. N. 4193.
1909.45	167°.6	5".57	De (3n).

$\beta$  7259. Distance probably erroneous, though separate measures agree beautifully (1".85 and 1".73).

1904.61	68°.6	1".06	(5n) Strbg.
1906.22	62°.1	1".02	(2n) A.

$\beta$  7327. Relative p.m. from three sets (1903-1919)

$$\mu_{\alpha} = -0''.094, \mu_{\delta} = -0''.076.$$

Pair of equal magnitude.

$\psi$  Serp. Aa.  $\mu_{\alpha} = -0''.047, \mu_{\delta} = +0''.135.$

(Boss,  $\mu_{\alpha} = -0''.086, \mu_{\delta} = +0''.150.$ )

$\beta$  7442. From four sets (1879-1919) (first epoch one night only),

$$\mu_{\alpha} = +0''.040, \mu_{\delta} = -0''.037.$$

Meridian p.m. larger, *cf.* (P.M.).

15 Herc. AB. From four sets (1887-1919),

$$\mu_{\alpha} = -0''.044, \mu_{\delta} = -0''.065.$$

Meridian p.m. discordant, *cf.* (P.M.).

$\beta$  7699. Both stars have a common p.m. of 0".112 (Radcl, 1890).

Perhaps some increase in distance detected (*cf.* Gen. Cat.), if so this is a pair of the 61 Cygni type.

30 Oph. From four sets, (1887-1919),

$$\mu_{\alpha} = -0''.040, \mu_{\delta} = +0''.038.$$

Does not agree with meridian p.m., *cf.* (P.M.), but the older measures are discordant.

$\beta$  7858 AC. From two sets (1907-1919),

$$\mu_{\alpha} = -0''.011, \mu_{\delta} = +0''.051.$$

For p.m. from AB, *cf.* (P.M.).

B.D. 42°.2810. The large motion, given in the *Bul. Ac. Sci. Petersbourg*, Febr. 1912, is real.

From two sets, (1912-1919),

$$\mu_{\alpha} = -0''.964, \mu_{\delta} = +0''.516.$$

B.D. 18°.3424. The proper motion of the principal star (1".255 in 314°.5) is not confirmed by my measures of  $\Delta\delta$  of AB and AC.

$\beta$  8295 AB. From five sets of measures, (1874-1919),

$$\mu_{\alpha} = -0''.046, \mu_{\delta} = -0''.107.$$

AB is an equal-magnitude pair (7.0-7.1).

$\beta$  8295 BC. The measures of BC prove that A is at rest.

From two sets (1911-1919),

$$\mu_{\alpha} = +0''.038, \mu_{\delta} = +0''.101.$$

$\beta$  8404 AB. From four sets (1868-1918),

$$\mu_{\alpha} = +0''.005, \mu_{\delta} = +0''.033.$$

Oxf.  $26^{\circ}55'35.7$ . From photographs a large motion of the principal star (B.D.  $25^{\circ}37'80$ ) was detected.

From two sets with a very short interval (1910-1919),<sup>§</sup>I deduced

$$\mu_{\alpha} = +0''.152, \mu_{\delta} = -0''.170.$$

$\beta$  9150. Probably fixed. Other measures are :

1881.46	$271^{\circ}2$	$3''.30$	(3n) $\beta$ .
1887.80	$269^{\circ}2$	$3''.01$	(3n) Com.
1905.68	$269^{\circ}4$	$2''.94$	(1n) $\beta$ .
1908.89	$268^{\circ}3$	$3''.07$	(3n) De.
1910.87	$270^{\circ}5$	$2''.72$	(3n) Doo.

$\beta$  9607 AD. p.m. small but real. From three sets (1880-1918),

$$\mu_{\alpha} = +0''.009, \mu_{\delta} = -0''.025.$$

$\beta$  9652. No change in angle since 1907. The angle which  $\beta$  deduces from A.G. Leipzig is probably erroneous.

15 Sagittæ AB. The relative motion of AB from three sets (1886-1918) is

$$\mu_{\alpha} = -0''.362, \mu_{\delta} = +0''.354.$$

15 Sagittæ AC. The relative motion of AC from three sets (1886-1918) is

$$\mu_{\alpha} = -0''.384, \mu_{\delta} = +0''.390.$$

Therefore the motion of C, if B is at rest:

$$\mu_{\alpha} = +0''.022, \mu_{\delta} = -0''.036.$$

15 Sagittæ Bb. The hypothesis that B is at rest is confirmed by the measures of Bb, which show no perceptible change between 1908-1918.

29 Cygni AB. From three sets (1887-1918) the relative motion of A is

$$\mu_{\alpha} = +0''.024, \mu_{\delta} = -0''.034.$$

29 Cygni AC. From four sets (1887-1918) the relative motion of A is

$$\mu_{\alpha} = +0''.098, \mu_{\delta} = -0''.083.$$

For meridian motions of A and B, cf. (P.M.).

29 Cygni BD. From three sets (1894-1918) the relative motion of B is

$$\mu_{\alpha} = -0''.065, \mu_{\delta} = +0''.040.$$

Dec. 1919. *Measures of Double and Proper-Motion Stars.* 237

Cephei H 6. From three sets (1894-1918),

$$\mu_{\alpha} = -0''.100, \mu_{\delta} = +0''.253.$$

For meridian p.m., *cf.* (P.M.).

Lal. 40604. A and B have both different large proper motions. They have been both connected to the star C, which in its turn is connected to a faint star D. The relative motion of CD is very small, if not unreal. From two sets with an interval of ten years,  $\mu_{\alpha} = +0''.049$ ,  $\mu_{\delta} = +0''.033$ ; a measure of Engelmann on one night being rejected as erratic.

From three sets of AC (1894-1918), the p.m. of A is

$$\mu_{\alpha} = +0''.261, \mu_{\delta} = -0''.200.$$

From two sets of BC (1908-1918), the p.m. of B,

$$\mu_{\alpha} = -0''.134, \mu_{\delta} = +0''.073.$$

The direct measures of AB do not agree with these results.

B.D. 10° 4481. From three sets (1892-1918)

$$\mu_{\alpha} = +0''.216, \mu_{\delta} = -0''.043.$$

For meridian p.m., *cf.* (P.M.).

Oxf. 26° 74272. Large p.m. detected on photographs.

From two sets with very short interval (1910-1918),

$$\mu_{\alpha} = -0''.333, \mu_{\delta} = +0''.139.$$

Br. 2926. From four sets (1887-1918),

$$\mu_{\alpha} = +0''.241, \mu_{\delta} = -0''.124.$$

In excellent accordance with meridian p.m., *cf.* (P.M.).

ε Cephei. From four sets (1887-1918),

$$\mu_{\alpha} = +0''.460, \mu_{\delta} = -0''.036.$$

In good accordance with meridian p.m.

β 11641 BC. From three sets (1880-1918) of BC,

$$\mu_{\alpha} = +0''.050, \mu_{\delta} = -0''.060.$$

12 Andr. β wrongly supposes that the difference between the meridian p.m. of A and that deduced from his measures is due to errors of measurement. B most certainly has a p.m. of its own.

From four sets (1886-1918),

$$\mu_{\alpha} = +0''.079, \mu_{\delta} = -0''.001.$$

Boss gives for A,

$$\mu_{\alpha} = +0''.115, \mu_{\delta} = +0''.078.$$

Therefore absolute p.m. of B,

$$\mu_{\alpha} = +0''.036, \mu_{\delta} = +0''.079.$$

238 *Measures of Double and Proper-Motion Stars.* LXXX. 2.

Pi. XXIII. 164. The p.m. of A is derived from five neighbouring stars, all measured at three epochs (1894-1918). The separate results agree well, and give no indications as to individual p.m. of the reference stars.

p.m. of A	$\mu_\alpha$	$\mu_\delta$	mean
From AB	+0".373	-0".476	
„ AC	+0".356	-0".507	$\mu_\alpha = +0".375$
„ AD	+0".380	-0".473	$\mu_\delta = -0".489$
„ AE	+0".372	-0".497	
„ AF	+0".392	-0".493	

$\beta$  12538. An interval of eight years, too short for deduction of p.m.

$\beta$  12608 AC. From four sets (1894-1918),

$$\mu_\alpha = +0".310, \mu_\delta = -0".055.$$

Boss gives for A,

$$\mu_\alpha = +0".329, \mu_\delta = -0".052.$$

$\beta$  12656 AC. My measures disagreeing with those of 1892-1909, no reliable p.m. can be deduced.

$\beta$  12693 Aa. From three sets (1879-1918),

$$\mu_\alpha = -0".018, \mu_\delta = -0".018.$$

Nowhere are other values for the p.m. to be found.

$\beta$  12693 Bb. From measures in 1879, 1909, and 1918, p.m. imperceptible.